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RESTORATIONS OF CERTAIN DEVONIAN CEPHALOPODS WITH DESCRIPTIONS OF NEW SPECIES

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A cephalopod fauna remarkable for the form of some of its species as well as for the abundance of individuals occurs in the hydraulic limestone of Middle Devonian age near Milwaukee, Wis. The specimens are crushed to such an extent by pressure applied at various angles with reference to the vertical axis, that a hasty study would probably result in their separation into a large number of species and perhaps genera. In fact, early collectors were led to believe that at least twenty species were represented, whereas, all should probably be included in nine or ten species.

In order that these distorted forms might be clearly understood, and to reduce as much as possible the liability to error in their determination, restorations in clay and later in plaster were made from careful measurements of actual specimens. In these restorations it was found necessary to restore the apex without reference to the fossils, since in no specimen was that portion of the shell preserved in its entirety. For example, in *Gomphoceras calvini* the lower one and one-quarter inches of the restoration is hypothetical, although in *G. wisconsinense* practically the whole specimen is known. The transverse section was made circular in the restorations of all the species. In the case of *G. wisconsinense* this was doubtless the true shape, but it is possible that in two of the restorations (*G. whitfieldi* and *G. fusiforme*) the cross-section was elliptical.

The rim of the aperture of *G. wisconsinense*, *G. calvini*, and *G. fusiforme* is pretty well known, but in *G. whitfieldi* its exact contour is in doubt. It is difficult in all cases to determine the position, if any, of the hyponomic sinus.

It should be remembered that the restorations in this paper are in every case of the interior. If a restoration were made of the exterior, account must necessarily be taken of the thickening of that portion of the shell forming the chamber of habitation. In none of our

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specimens is this thickening indicated, but it has been shown by Dr. R. Ruedemann¹ that in certain Ordovician cephalopods "the slight constriction of the living chamber [shown in the cast of the interior] is largely due to a thickening of the shell in apertural direction, evidently a gerontic feature." It is possible that the exteriors of the



FIG. 1.—Lateral view of an exceptionally well-preserved specimen of *Gomphoceras wisconsinense* N. S. The measurements from which the model (Fig. 2) was constructed were largely from this specimen. The original is from Milwaukee and is now in the Public Museum, Milwaukee.

upper portion of the shells of *G. wisconsinense* and *G. calvini* were much less concave than the interior, or were even convex.

A comparison of these restorations with the fossils shows that a number of the specimens which appeared at first to be distinct species

¹ *Cephalopods of the Champlain Basin* (1906), p. 503, Fig. 57.

are only peculiarly distorted individuals of well-marked species. The species most distorted is *G. wisconsinense*, a unique and beautiful fossil. In this species it appears that the shell was comparatively thin. The peculiar shape of the shell probably caused a whirling motion as the dead animal sank through the waters to the soft bottom of calcareous mud, where it rested in the position it had in the water immediately before striking the bottom. As a result of this whirling motion, it was seldom that two individuals struck the bottom at precisely the same angle. The effect, whether due to impact or to the weight of the superimposed sediments, was a distortion in different planes resulting in a great variety of fossil forms. In the case of the other species discussed in this paper it appears either that the shells were stronger, or that they reached the bottom with their vertical axis in approximately a horizontal position. Because of one or both of these conditions, the outlines, except in the transverse section, is little changed.

The outline of the shells, as has been said, is quite well known, but the internal structure is poorly preserved. The air-chambers are usually preserved, but the position of the siphuncle is, in some species, in doubt, and in only one species is the relation between the siphuncle and hyponomic sinus shown.

The impossibility of determining the position of the siphuncle compels the use of the broader classification used in the older literature.

***Gomphoceras wisconsinense* n. sp.**

(Figs. 1, 2, 3)

Description.—Shell very large, straight, extremely gibbous. Longitudinal section like a pointed amphora. Between the last septum and the apex the



FIG. 2.—A restoration in plaster of *Gomphoceras wisconsinense* N. S. The shape of the apex is somewhat in doubt.

shell rapidly enlarges, becoming ventricose, and then more gradually narrows to near the aperture, where it flanges out.

Chamber of habitation large, about one-third the total length of the shell, gradually enlarging to the last septum. In all specimens the chamber is concave near the aperture, but not in the same degree. No other specimen shows this



FIG. 3.—Exterior view of a crushed specimen of *Gomphoceras wisconsinense* N. S., with a parasitic growth of coral. The dark band near the top of the specimen is a band of pyrite or marcasite which is present on practically all of the specimens a short distance above the last septum, the significance of which is not understood. The original is from Milwaukee and is now in the Public Museum, Milwaukee.

character as strongly developed as the one figured (Fig. 1). Diameter of an uncrushed specimen about 10.5^{cm}. Apertural margin straight.

Air-chambers more than 20, increasing in frequency toward the apex and

varying in width from 16^{mm} near the chamber of habitation to less than 5^{mm} near the apex.

Surface and siphuncle unknown.

One individual of medium size which is crushed laterally measures about 22^{cm} in length and 15^{cm} in its greatest diameter, the actual diameter of the circle being about 10.5^{cm}.

This species most resembles *Gomphoceras mitra* Hall from the Upper Helderberg Limestone of Lexington, Ind.,¹ but differs from it in essen-

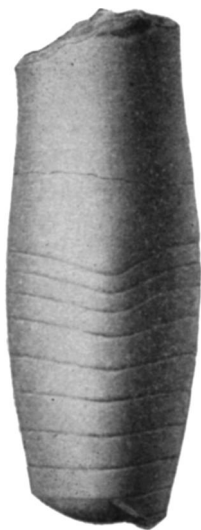


FIG. 4.—Exterior view of the concave portion of a well-preserved specimen of *Gomphoceras calvini*.

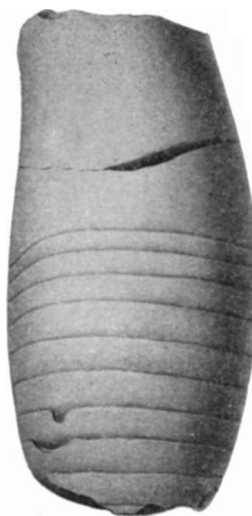


FIG. 5.—View of *Gomphoceras calvini* N. S., showing the unsymmetrical shape of the upper portion due to the leaning to one side of the chamber of habitation.

tial points. A more careful study of certain species of Gomphoceras from New York, Indiana, and Ohio will show a close relation to *G. wisconsinense*.

Specimens of this cephalopod occur rarely in the Milwaukee Cement Quarry. They are called "horses' hoofs" by the quarrymen because of a fancied resemblance to a hoof. The many shapes

¹ *Paleontology of New York*, Vol. V, Part 2, p. 330, and Plate 119, Supplement Vol. V, Part 2.

in which they occur—due to crushing—have given rise to the belief that a number of species are represented. This, however, does not



FIG. 6.—Transverse section showing the marginal position of the siphuncle in a crushed specimen of *Gomphoceras calvini* N. S.

seem to be the case, as a comparison with the restoration will show (Fig. 3). The shell appears to have been quite thin and easily distorted, in some cases one side being apparently pushed in until it became concave and in contact with the opposite side.

Named for the state of Wisconsin.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis.

***Gomphoceras whitfieldi*, n. sp.**

(Figs. 9, 10)

Description.—Shell medium, sub-triangular in a longitudinal section. Transverse section oval or circular. Conch rapidly and regularly enlarging to the point of greatest transverse section, which is about midway between the last septum and the aperture of the chamber of habitation, thence contracting more gradually to the aperture. Apical angle about 45° .

Chamber of habitation wide, but very short; length in one specimen about 3.5^{cm} and greatest diameter about 6.25^{cm}. Aperture large, oval or circular in the border of which there appears to be a sinus.

Air-chambers regular, varying little in depth from the chamber of habitation to near the apex.

Surface and siphuncle unknown.

Length of two individuals about 13^{cm}; greatest diameter of a crushed specimen about 9^{cm}.

This species differs from *G. calvini* in its more acute apical angle, its symmetrical form, and its shorter chamber of habitation; from *G. breviposticum* and *G. fusiforme* in its greater size, relatively shorter chamber of habitation, and more obtuse apical angle.

In the restoration the only points in



FIG. 7.—Restoration in plaster of *Gomphoceras calvini* N. S. The shape of the apex and a portion of the apertural opening are somewhat in doubt.

doubt are the aperture and the transverse section, which may have been somewhat elliptical or subcircular.

Named in honor of Professor R. P. Whitfield, who, besides other well-known writings, has written several papers on the Wisconsin Devonian.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis.



FIG. 8.—A specimen of a goniatite which appears to be a new species, but in which the characters are not sufficiently well preserved for specific identification.

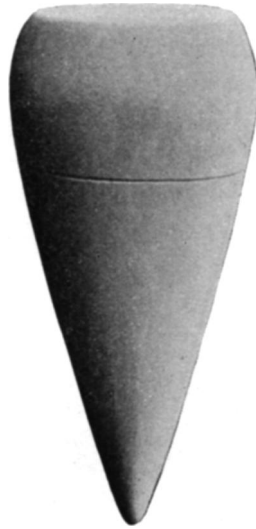


FIG. 9.—Restoration of *Goniatites whitfieldi* N. S. In this restoration the cross-section is circular. It is, however, possible that the cross-section of the species was oval.

***Goniatites calvini*, n. sp.**

(Figs. 4, 5, 6, 7)

Description.—Shell large, fusiform. Transverse section oval or circular. Tube regularly enlarging from near the apex to the greatest transverse diameter which is posterior to the chamber of habitation, at the third or fourth septum; thence contracting to the aperture, but hanging to one side in old age.

Chamber of habitation large. Air-chambers irregular, varying in depth within 9^{cm} of the chamber of habitation, from 5 to 10^{mm}. Hyponomic sinus shallow and apparently on the concave side.

Siphuncle in a crushed specimen 7^{mm} from the periphery on the concave side. Surface unknown. Internal mold frequently covered with parasitic bryozoa and worm (?) tracks.

In none of the specimens which are referred to this species is the apex retained. This species resembles *G. fischeri* of the New York Marcellus, but differs from it in the arrangement of septa. It also resembles *G. plena* Hall.¹

The restoration of this species was difficult because of the poor

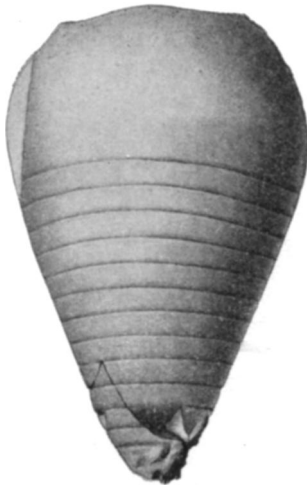


FIG. 10.—View of a crushed specimen of *Gomphoceras whitfieldi* N. S., in which the entire length of the chamber of habitation is preserved.



FIG. 11.—A crushed specimen of *Gomphoceras fusiforme whitfieldi*, showing the position of the sutures and the length of the chamber of habitation.

preservation of the fossils. The apical angle and the rim of the aperture are somewhat in doubt, but are probably correctly shown. It is possible that the transverse section was broadly elliptical. Because of the unsymmetrical form the specimens are usually crushed in the same plane.

Named in honor of Professor Samuel Calvin, State Geologist of Iowa.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis. They occur commonly in the "hard layer."

¹ *Paleontology of New York*, 1888. Supplement to Vol. V, Part 2, Plate 121 A.

Gomphoceras breviposticum Whitfield

(Fig. 13)

Gomphoceras breviposticum Whitfield: *Geology of Wisconsin*, Vol. IV (1873-79), p. 339, Plate XXVI, Fig. 15.

Description.—"Shell rather below medium size, very rapidly expanding from below upward, the rate of increase more rapid toward the base of the outer chamber than in the earliest stages of growth, and again decreasing in the same rate to near the middle of the chamber, and gently contracted above to the aperture. The rate of increase in the type specimen in a length of two inches below the point of greatest diameter, is from a little less than five-eighths of an inch to one inch and seven-eighths; septa moderate, those preserved being about one-eighth of an inch apart, siphuncle lateral in the specimen; aperture sharply sinuate on one side, at a distance of one-fourth of the circle from the position of the siphuncle. No evidence of the lobed contraction of the aperture, as in the Silurian examples of the genus, exists." The siphuncle is on the dorsal side.



FIG. 13.—External view of the chamber of habitation and two air-chambers of *Gomphoceras breviposticum whitfield*. It is possible that this species is a young form of *G. fusiforme*.

It is possible that *G. fusiforme* Whitfield and *G. breviposticum* Whitfield are of the same

species. The differences in the chamber of habitation may be due to age. The shells are almost identical in size, in the depth of the air chambers, and the margin of the aperture.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis.; "Whitefish Bay, near Milwaukee."

Gomphoceras[*fusiforme* Whitfield

(Figs. 11, 12)

Gomphoceras (?) *fusiforme* Whitfield: *Geology of Wisconsin*, Vol. IV (1873-79), p. 338, Plate XXVI, Fig. 16.

Description.—"Shell rather below a medium size, very moderately expanding from below upward to near the middle of the outer chamber, as seen on the type specimen, about which it again decreases to the aperture somewhat more abruptly than below. Section circular, or very nearly so, the slight flattening of the specimen probably due to compression. Septa not distinctly defined in the specimen, but apparently about one-sixteenth to one-twelfth of an inch apart, and but



FIG. 12.—Restoration in plaster of *Gomphoceras fusiforme whitfield*.

slightly concave." [Septa 5^{mm} apart at the chamber of habitation, and 3^{mm} apart 3^{cm} from the chamber. Siphuncle marginal.]

This species resembles *G. tumidum* Hall of the Chemung shales of New York.

It is possible that this is an old-age form of *G. breviposticum*. For discussion on this point see description of that species.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis., especially abundant in the "hard layer;" "Whitefish Bay, near Milwaukee."

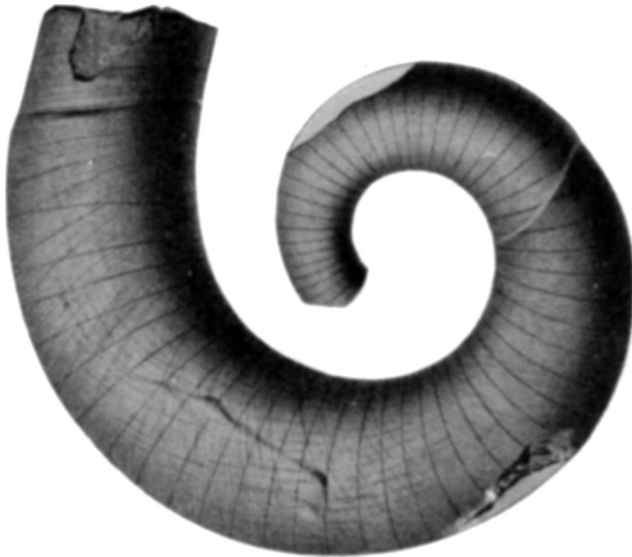


FIG. 14.—Exterior view of a remarkably well-preserved specimen of *Gyroceras clarkei* N. S., in which what appear to be traces of both transverse and longitudinal color markings are retained. The original is from the Public Museum, Milwaukee.

Gomphoceras sp.

(Fig. 8)

Description.—An almost perfect specimen of a large Gomphoceras, differs from other Milwaukee cephalopods in that it is subfusiform and has a large chamber of habitation which contracts slightly toward the aperture. Septa 3 or 4^{mm} apart near the chamber of habitation, but 9 to 10^{mm} apart 6.5^{cm} from the chamber. Transverse section apparently elliptical. The greatest diameter appears to be at about the tenth septum.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis.

Gyroceras eryx Hall, n. sp.

(Fig. 14)

Description.—Shell large, regularly coiled, forming a very open spiral, making about one and one-half volutions. Regularly enlarging from near the apex to the chamber of habitation. Oval or circular in transverse section. Apex unknown. Greatest diameter of the coil 17 cm.

Chamber of habitation comparatively short, and in one specimen appears to be contracted toward the aperture. Aperture not clearly shown, but apparently has a shallow hyponomic sinus on the convex side.

Septa numerous, regular, with straight transverse sutures which near the chamber of habitation are 9^{mm} apart on the convex side, and 5^{mm} apart on the inner side.

Siphuncle small, situated about one-third the diameter of the shell from the lower side.

What appear to be surface markings are preserved on the inner mold and show fine growth lines swinging backward and crossing the septa at an angle of about ten degrees. Fine irregular longitudinal lines which appear to be vestiges of color markings are also shown.

Locality.—Milwaukee Cement Quarry, Berthelet, Wis.